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⑪ pH buffering method.

⑫ A novel buffering method for a solution which contains metal ions usually forming an insoluble metal salt with a phosphoric acid salt, characterized in that one or more salts of phosphoric esters selected from salts of sugar phosphoric esters and glycerophosphoric acid salts are added.

The method can be widely utilized in the fields of food, medicines, cosmetics and the like.

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pH BUFFERING METHOD

BACKGROUND OF THE INVENTION

1) Field of the invention

This invention relates to a buffering method in which a pH of a solution containing metal ions, which would otherwise form insoluble metal salts with phosphoric acid salts, is buffered without formation of any insoluble metal salts.

2) Description of the Prior Art

Phosphoric acid salts have the capability of buffering pH and have wide utilization in various fields of industries as a pH buffering agent. In view of the fact that phosphoric acid salts have the function of pH buffering in living body, they are one of important pH buffering agents.

In the field of certain products including food and medicines which are taken in living body orally, intravenously or percutaneously, phosphoric acid salts are widely used as a pH buffering agent from the standpoints of a pH buffering range, safety and cost. On the other hand, in the specific fields of food, medicines, cosmetics and fragrance materials, it is frequently experienced to add alkaline metal ions such as Ca, Mg, and the like, transition metal ions and the like so as to enhance the functional properties of the products.

However, these metal ions react with phosphoric acid salts to form insoluble metal salts, causing the pH buffering ability to lower and an undesirable phenomenon such as of turbidity to occur. This involves a problem of considerably lowering the values of the products such as food, medicines, cosmetics, fragrance materials and the like.

SUMMARY OF THE INVENTION

The present inventors made intensive studies to solve the above problem. As a result, it was found that salts of phosphoric esters such as salts of sugar phosphoric esters and glycerophosphoric acid salts have a good capability of pH buffering without formation of any insoluble metal salts in a solution in which such metal ions are present which will form insoluble metal salts by reaction with phosphoric acid salts.

More particularly, the present invention provides a pH buffering method for a solution in which there are present metal ions forming insoluble metal salts by reaction with phosphoric acid salts, the method characterized by adding one or more salts of phosphoric esters selected from the group consisting of salts of sugar phosphoric esters and glycerophosphoric acid salts.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a graphical representation of titration curves of buffering solutions of Examples 1 to 4;

Fig. 2 is a graphical representation of pH titration curves of buffering solutions of Examples 5 to 8;

Fig. 3 is a graphical representation of pH titration curves of buffering solutions of Example 9; and

Fig. 4 is a graphical representation of pH titration curves of buffering solutions of Comparative Examples 1 to 6.

DETAILED DESCRIPTION OF THE INVENTION AND PREFERRED EMBODIMENTS

The salts of phosphoric esters used in the present invention are salts of phosphoric esters with monosaccharides, disaccharides and polysaccharides, and salts of glycerophosphoric esters. Examples of the salts include salts between glucose-1-phosphate, glucose-6-phosphate, mannose-6-phosphate, galactose-6-phosphate, fructose-6-phosphate, glucose-1,6-diphosphate, fructose-1,6-diphosphate, alpha-glycerophosphoric acid, beta-glycerophosphoric acid and the like and Na, K, Ca, Mg, NH₄, amines, alkanolamines, amino acids and the like. Preferable examples include Na, K, Ca, Mg, Fe and arginine salts of glucose-1-phosphate, glucose-6-phosphate, fructose-6-phosphate, fructose-1,6-diphosphate, beta-glycerophosphoric acid and the like.

Metal ions forming insoluble metal salts by reaction with phosphoric acid salts may be alkaline earth metals such as Ca, Mg, Ba and the like, Zn, Ti, Al, Cr, Mn, Pb, Sn, Cu, Ni and the like. As a matter of course, two or more metal ions may coexist.

The concentration of metal ions forming insoluble metal salts with phosphoric acid salts present in a solution is not critical. For instance, even through metal ions are present in large amounts such that their molar concentration exceeds a mo-

lar concentration of a phosphoric acid salt, the resultant metal salt of the phosphoric ester is soluble in water and the solution is transparent, showing a satisfactory pH buffering capability.

The concentration of a salt of a phosphoric ester used in the present invention may vary depending on the degree of the pH buffering capability required and is thus not critical.

The pH buffering range varies depending on the types of acid component and base component constituting a pH buffering system. When a salt of a phosphoric ester is used as both an acid component and a base component, an effective pH buffering range is from 4 to 8, most preferably from 5 to 7. On the other hand, when a salt of a phosphoric ester is used as either an acid component or a base component and a component other than the phosphoric ester salt is used as a counter base or acid component, the pH may be buffered in an acidic range below 4 or in a basic range over 8. The present invention is not limited to a specific buffering range of pH.

The solution in which metal ions are present may comprise any compounds not impeding the pH-buffering capability of the phosphoric ester salt, e.g., water-soluble solvents, surface active agents, sugars, lipids, amino acids, proteins and the like.

The present invention provides a method for pH buffering of a solution in which metal ions forming insoluble metal salts by reaction with phosphoric acid salts are present, which method comprising adding a salt of a phosphoric ester as a pH buffering agent where the pH is buffered without formation of any insoluble metal salts. This method can be widely utilized in the fields of food, medicines, cosmetics, fragrance, materials and the like including, more particularly, drinks, nourishing drinks, transfusions, eye drops, oral hygienic articles, bath agents.

Examples and comparative examples are described to illustrate the invention.

Example 1

1 liter of ion-exchanged water was added to 0.11 g of CaCl_2 to prepare an aqueous solution with a Ca^{++} ion concentration of 0.001 mol/l.

3.80 g of dipotassium glucose-1-phosphate $\cdot 2\text{H}_2\text{O}$ (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant solution was found to be transparent with a pH of 8.4. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 1. The solution had a pH buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution

was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 2

1 liter of ion-exchanged water was added to 11.1 g of CaCl_2 to prepare an aqueous solution with a Ca^{++} ion concentration of 0.01 mol/l.

3.80 g of dipotassium glucose-1-phosphate $\cdot 2\text{H}_2\text{O}$ (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 8.3. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 1. The solution had a pH buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 3

1 liter of ion-exchanged water was added to 11.1 g of CaCl_2 to prepare an aqueous solution with a Ca^{++} ion concentration of 0.1 mol/l.

3.80 g of dipotassium glucose-1-phosphate $\cdot 2\text{H}_2\text{O}$ (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 8.0. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 1. The solution had a pH buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 4

1 liter of ion-exchanged water was added to 1.1 g of CaCl_2 to prepare an aqueous solution with Ca^{++} ion concentration of 0.01 mol/l.

3.10 g of disodium glucose-1-phosphate (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 8.4. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 1. The solution had a pH buffering range of

from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 5

1 liter of ion-exchanged water was added to 1.11 g of CaCl_2 to prepare an aqueous solution with a Ca^{2+} ion concentration of 0.01 mol/l.

3.10 g of disodium glucose-1-phosphate (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 8.4. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 2. The solution had a pH buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 6

1 liter of ion-exchanged water was added to 1.11 g of CaCl_2 to prepare an aqueous solution with a Ca^{2+} ion concentration of 0.01 mol/l.

3.58 g of disodium fructose-6-phosphate \cdot 2.5 H_2O (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 8.5. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 2. The solution had a pH buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 7

1 liter of ion-exchanged water was added to 1.11 g of CaCl_2 to prepare an aqueous solution with a Ca^{2+} ion concentration of 0.01 mol/l.

3.12 g of disodium beta-glycerophosphate \cdot 5 H_2O (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 8.5. A 1/10N HCl aqueous solution was

further added to the solution for pH titration. The pH titration curve is shown in Fig. 2. The solution had a pH buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 8

1 liter of ion-exchanged water was added to 2.03 g of $\text{MgCl}_2\cdot 6\text{H}_2\text{O}$ to prepare an aqueous solution with a Mg^{2+} ion concentration of 0.01 mol/l.

3.80 g of dipotassium glucose-1-phosphate \cdot 2 H_2O (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 8.2. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 2. The solution had a buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Example 9

1 liter of ion-exchanged water was added to 2.88 g of $\text{ZnSO}_4\cdot 7\text{H}_2\text{O}$ to prepare an aqueous solution with a Zn^{2+} ion concentration of 0.01 mol/l.

3.80 g of dipotassium glucose-1-phosphate \cdot 2 H_2O (purity 98%, 0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was found to be transparent with a pH of 7.1. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 3. The solution had a pH buffering range of from 5 to 7. During and after addition of 100 cc of a 1/10N HCl aqueous solution, the solution was transparent. The solution after addition of 50 cc of a 1/10N HCl aqueous solution was left as transparent on storage at 25°C for 1 week and no changes were observed.

Comparative Example 1

1 liter of ion-exchanged water was added to 0.11 g of CaCl_2 to prepare an aqueous solution with a Ca^{2+} ion concentration of 0.001 mol/l.

1.74 g of K_2HPO_4 (0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was turbid with a pH of 8.2. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 4: The solution had a pH buffering range of from 6 to 8. During and after addition of 50 cc of a 1/10N HCl aqueous solution, the solution remained turbid, without showing any changes on storage at 25°C for 1 week.

Comparative Example 2

1 liter of ion-exchanged water was added to 1.11 g of $CaCl_2$ to prepare an aqueous solution with a Ca^{2+} ion concentration of 0.01 mol/l.

1.74 g of K_2HPO_4 (0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was in a very turbid state with a pH of 6.3. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 4. The solution had a pH buffering range of from 5 to 8. During and after addition of 50 cc of a 1/10N HCl aqueous solution, the solution remained turbid, without showing any changes on storage at 25°C for 1 week.

Comparative Example 3

1 liter of ion-exchanged water was added to 1.11 g of $CaCl_2$ to prepare an aqueous solution with a Ca^{2+} ion concentration of 0.1 mol/l.

1.74 g of K_2HPO_4 (0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was in a very turbid state with a pH of 5.5. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 4. The solution had a pH buffering range of from 4 to 5. During and after addition of 50 cc of a 1/10N HCl aqueous solution, the solution remained turbid, without showing any changes on storage at 25°C for 1 week.

Comparative Example 4

1 liter of ion-exchanged water was added to 2.03 g of $MgCl_2 \cdot 6H_2O$ to prepare an aqueous solution with a Mg^{2+} ion concentration of 0.01 mol/l.

1.74 g of K_2HPO_4 (0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was in a turbid state with a pH of 7.5. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 4. The solution had a pH buffering

range from 6 to 7. During and after addition of 50 cc of a 1/10N HCl aqueous solution, the solution remained turbid, without showing any changes on storage at 25°C for 1 week.

Comparative Example 5

1 liter of ion-exchanged water was added to 2.88 g of $ZnSO_4 \cdot 7H_2O$ to prepare an aqueous solution with a Zn^{2+} ion concentration of 0.01 mol/l.

1.74 g of K_2HPO_4 (0.01 mol) was added to and mixed with the solution. The resultant aqueous solution was in a turbid state with a pH of 4.6. A 1/10N HCl aqueous solution was further added to the solution for pH titration. The pH titration curve is shown in Fig. 4. The solution had a pH buffering range of from 3 to 5. During and after addition of 50 cc of a 1/10N HCl aqueous solution, the solution remained turbid, without showing any changes on storage at 25°C for 1 week.

Comparative Example 6

1 liter of ion-exchanged water was added to 1.11 g of $CaCl_2$ to prepare an aqueous solution with a Ca^{2+} ion concentration of 0.01 mol/l. The solution had a pH of 5.8.

A 1/10N HCl aqueous solution was further added to a solution for pH titration. The pH titration curve is shown in Fig. 4. The solution had a pH buffering range of from 2 to 3. During and after the addition of the 1/10N HCl aqueous solution, the solution was transparent, without showing any changes on storage at 25°C for 1 week.

Claims

1. A pH buffering method for a solution which contains metal ions usually forming a insoluble metal salt with a phosphoric acid salt, characterized in that one or more salts of phosphoric esters selected from salts of sugar phosphoric esters and glycerophosphoric acid salts are added.

FIG. 1

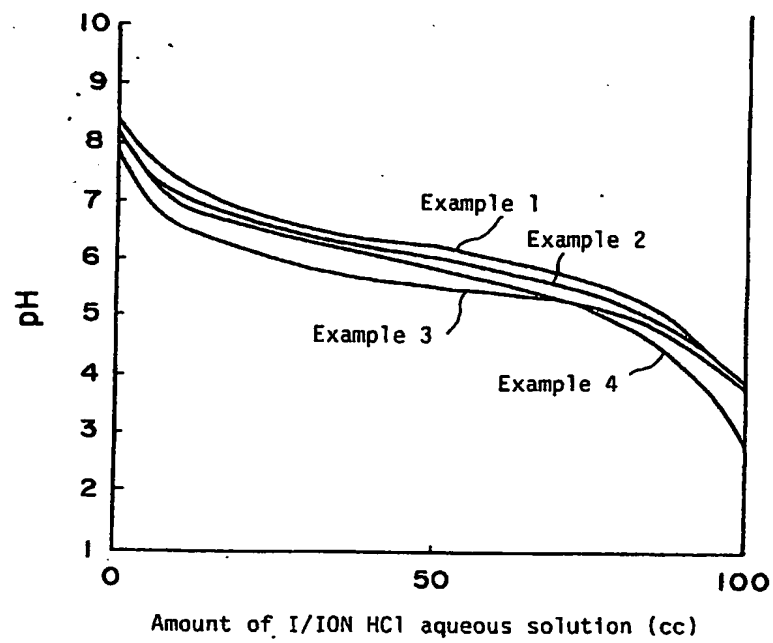


FIG. 2

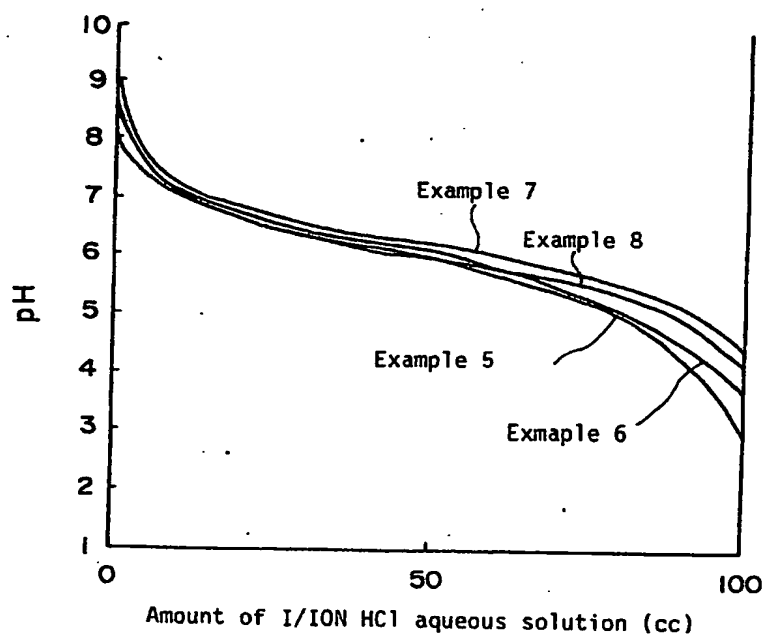
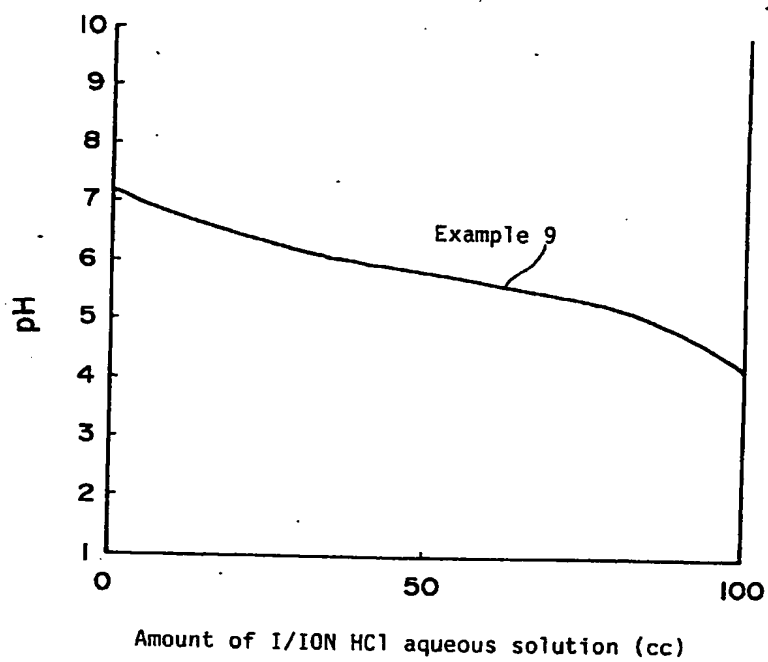


FIG. 3



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FIG. 4

